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Title: Corrosion Behavior Characterization of Tantalum in Flowing LBE

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Corrosion Behavior Characterization of Tantalum in Flowing LBE

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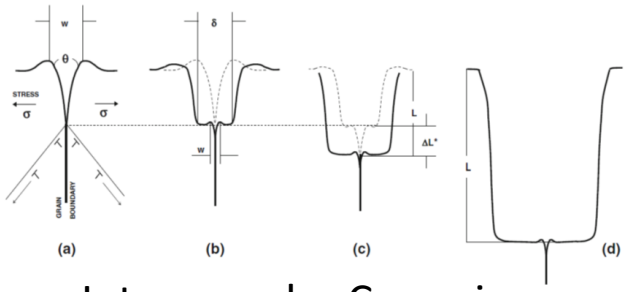
Tantalum Analysis

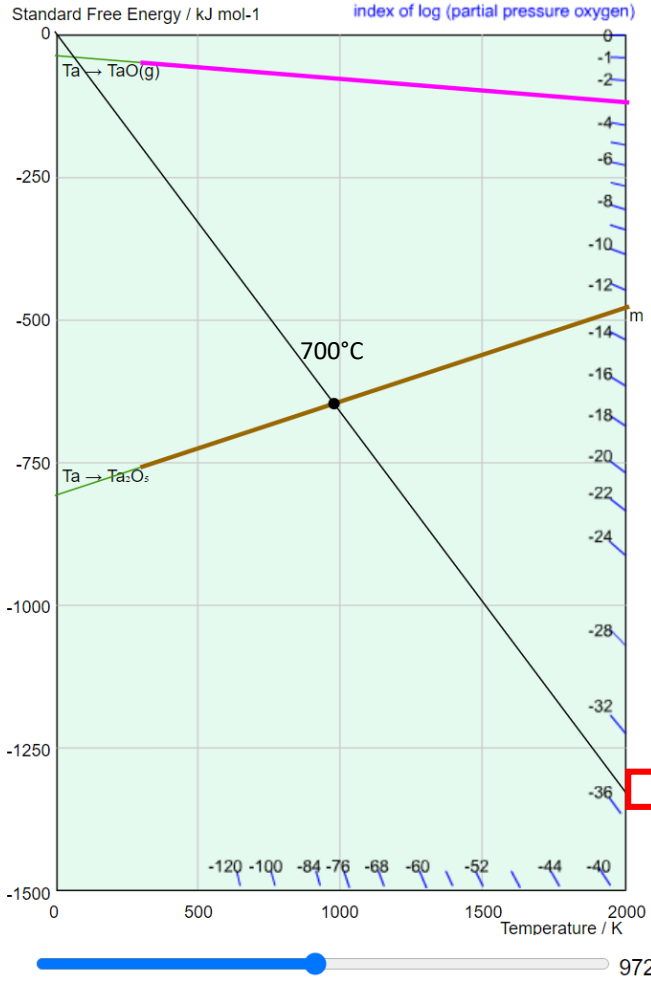
- Ta is a refractory metal, it has low coefficient thermal expansion and high creep resistance.
- Its BCC structure makes Ta less prone to radiation damage.
- It is 2nd most ductile among refractories.
- Its oxide (Ta_2O_5) layer is thin and stable at high temperatures and low oxygen concentrations (see Ellingham diagram on the right)

The oxygen concentration levels for the oxide stability are given for 700°C shown in red frames. The oxide stability at very low concentrations is crucial for the protection against crevice corrosion and intergranular corrosion due to the oxygen depletion during the penetration.

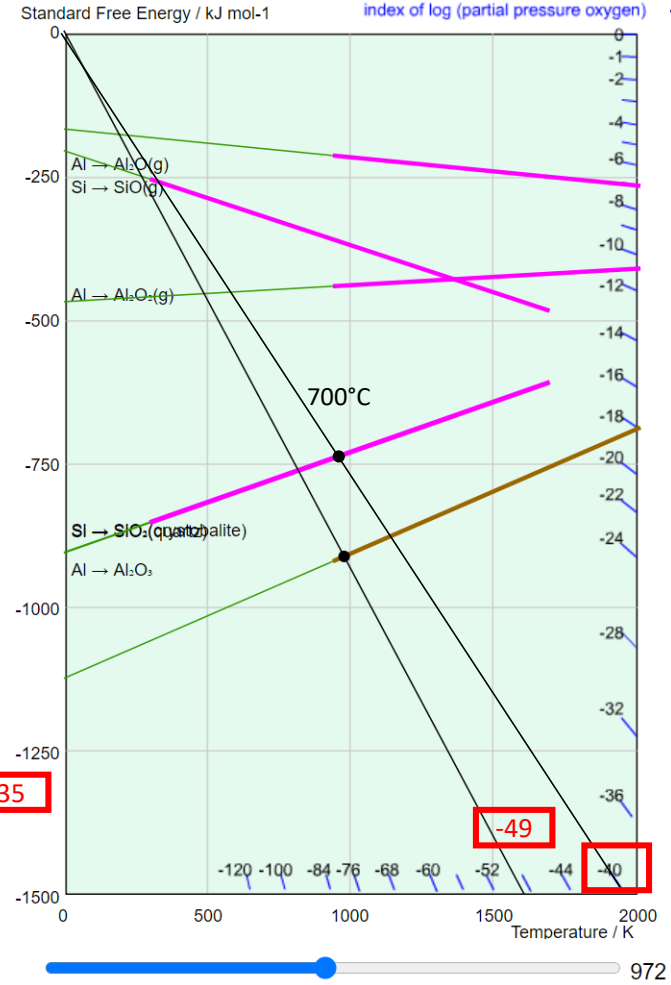


Intergranular Corrosion

* From Karl-Fredrik Nilsson and Anna Hojna, Overview of Mechanisms & Models for Liquid Metal Embrittlement and Future Directions EUR 29437 EN, Publisher, Luxembourg, 2018



Tantalum Oxide



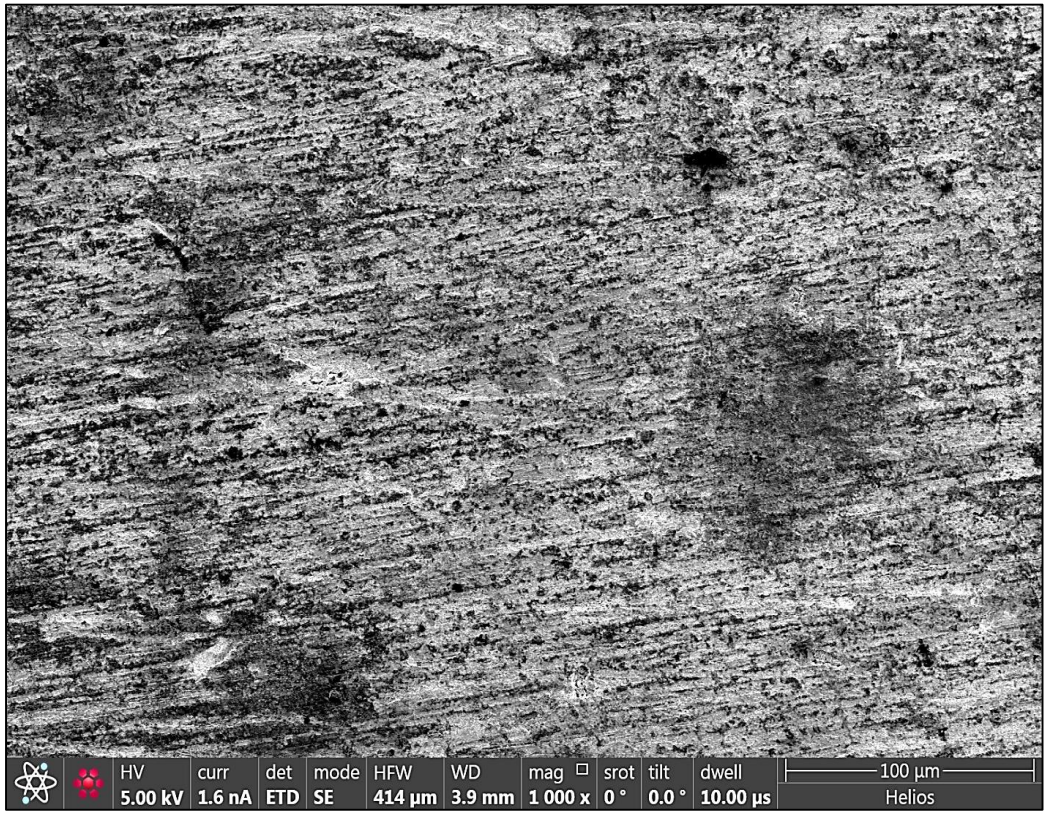
Alumina and Silica
(given for reference)

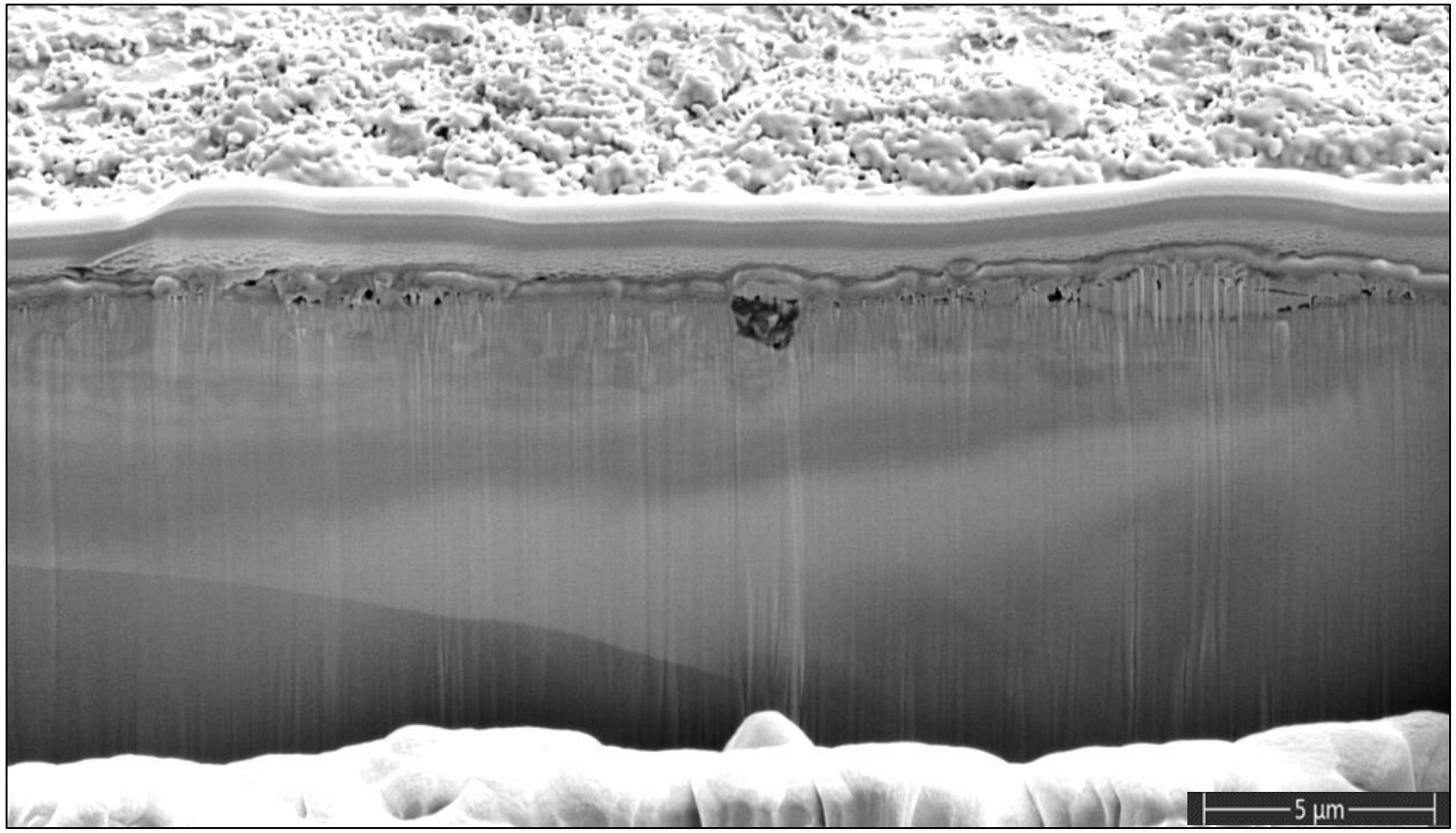
* Graphs from https://www.doitpoms.ac.uk/tlplib/ellingham_diagrams/interactive.php

Tantalum Analysis

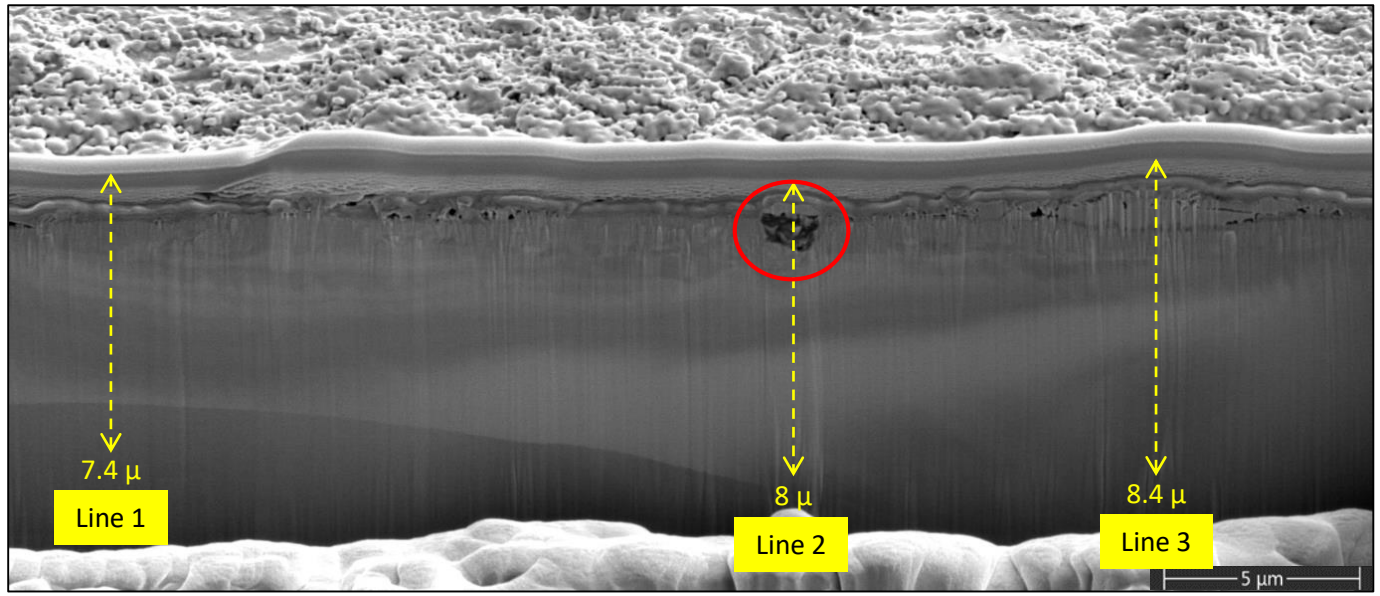
(Tested at 500°C 1000h flowing LBE 4.2 m/s from 1st test)

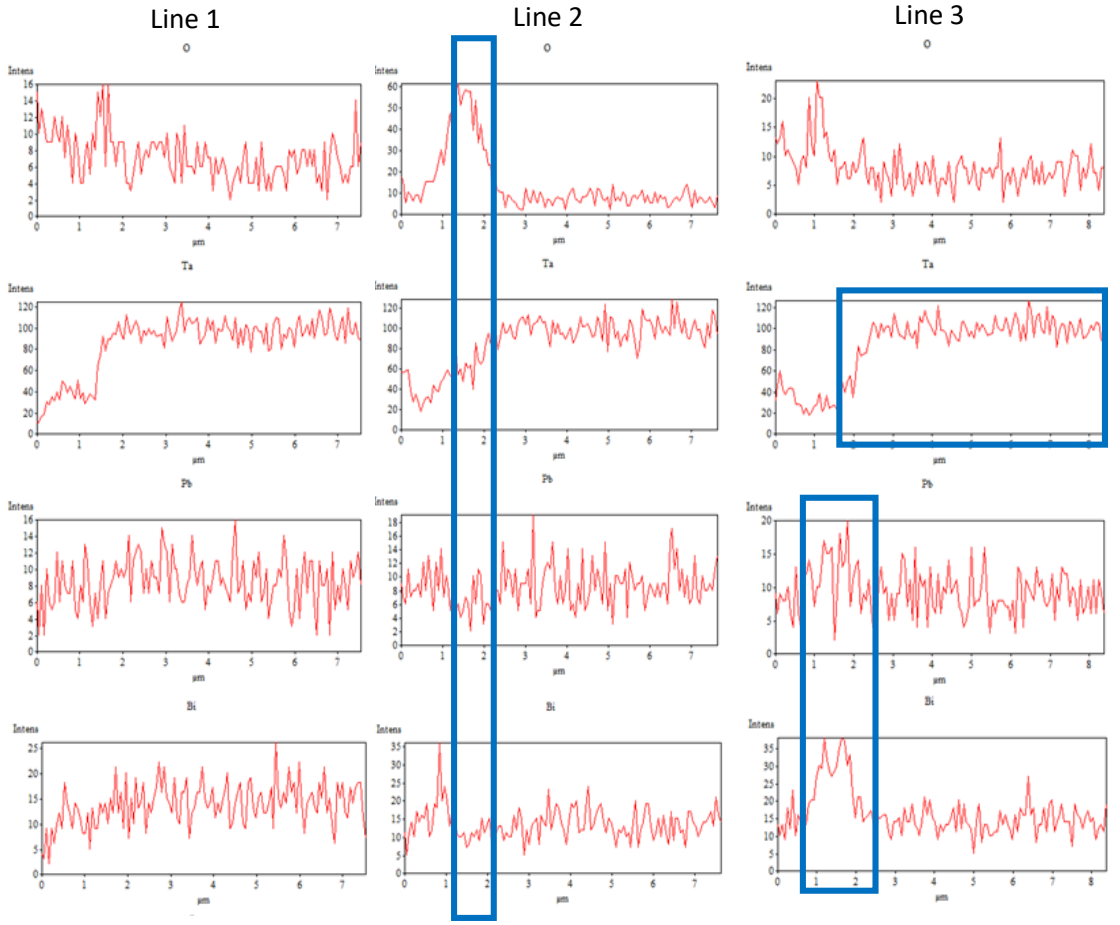
Figures show SEM images of the surface and the cross-section at a trench opened with FIB.





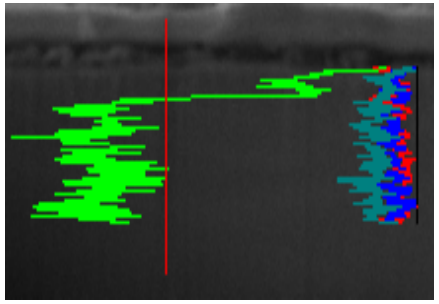
Tantalum EDS Line Scan Analysis



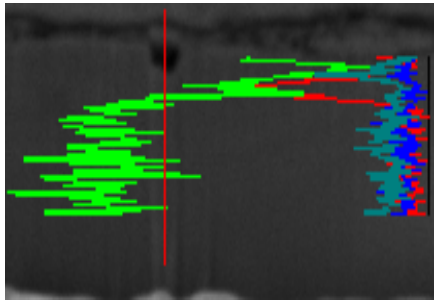


Tantalum – Oxygen – Lead - Bismuth

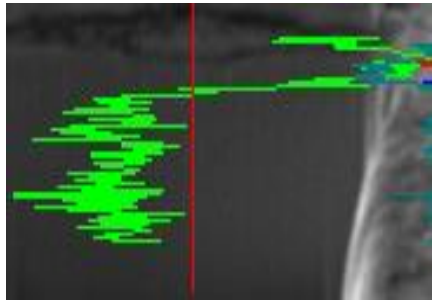
Line 1



Line 2



Line 3



- Line 2 shows no LBE penetration beneath oxide layer including the cavity.
- Line 3 has LBE formation beneath an oxide layer but it isn't a penetration into Ta.
- No observation of LBE penetration in Ta structure.